

ECOLOGICAL STUDY OF THE RARE
CHORIZANTHE VALIDA (POLYGONACEAE)
AT POINT REYES NATIONAL SEASHORE, CALIFORNIA

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ABSTRACT

The only known population of the rare Sonoma spineflower, *Chorizanthe valida*, is a colony within a coastal grassland subjected to cattle grazing. Exclosures were constructed and baseline data taken in and outside of the exclosures over four years. Inside the exclosures, *C. valida* demonstrated considerable phenotypic plasticity and experienced a remarkable population decline. Percent cover transects inside the exclosures revealed a 65% non-native plant cover. Outside the exclosures *C. valida* continued to thrive with cattle apparently grazing the non-native plants but not *C. valida*. A cattle grazing regime therefore had a positive influence on the perpetuation of a rare, endemic plant. *C. valida* seeds were sown into nearby grazed plots and monitored for three years. *C. valida* continues to reproduce on these sites. Soil analyses were performed for nutrients, pH, texture, and salinity. Recommendations for the management of this rare species are given.

The Sonoma spineflower, *Chorizanthe valida* Wats. (Polygonaceae), is known from a single population in Marin County, California. The flower is a California state listed endangered plant (Davis and Sherman 1990) and was recently granted federal endangered status (Federal Register 1992). The colony is located in a coastal grassland 200 m south of Abbotts Lagoon within Point Reyes National Seashore.

The first known collection of *Chorizanthe valida* was by Ilya G. Voznesensky who collected in northern California in 1840–1841 (Alekseev 1987). Watson (1877) first described *C. valida* from the holotype in the Russian collection (Davis and Sherman 1990; Howell 1937). While the genus has undergone considerable revision (Bentham 1836; Parry 1884; Goodman 1934; Reveal and Hardham 1989), *C. valida* has been regarded as a distinct species since its initial description in 1877. Reveal and Hardham (1989) recognize about 50 taxa of *Chorizanthe*. Most are predominantly cismontane and distributed on the west coasts of North and South America.

Chorizanthe is among the 20 largest genera in California (Noldeke and Howell 1960) but none of the *Chorizanthe* found in temperate North America is widespread or abundant (Stebbins 1974). The reasons for narrow geographical ranges of some California endemics are not clear (Ornduff 1974). Barbour et al. (1987) suggest that endemic plants are poor competitors. Stebbins (1974) considers *Chori-*

zanthe to be a recently derived genus of Polygonaceae and a plant pioneer on xeric sites where little or no competition with other plants would occur.

The narrow endemism of *Chorizanthe*, coupled with urbanization and agriculture, has promoted local extirpations and extinctions. Several species from the Pacific coast of North America have not been collected for years and some species are known from only one or a few populations (Reveal and Hardham 1989). Fifteen taxa are considered rare in California (Smith and Berg 1988). *Chorizanthe valida* was thought extinct for 77 years until a population was re-discovered in 1980 at Abbotts Lagoon (Davis and Sherman 1990). Historically *C. valida* was more widespread within the National Seashore. The plant was collected by Elmer in 1903 about 1.5 km south of the Abbotts Lagoon colony, northwest of Schooner Bay near the site of the Point Reyes Post Office and F Ranch (Fig. 1). Our surveys (1988–1991) and surveys by others (Fellers and Norris 1990) indicate that this population is extirpated.

The prehistory and ecology of grazing in California and the benefits of grazing to native plants are discussed by Edwards (1992). The ability of a plant to withstand grazing varies by species (Stoddart et al. 1975). Quantitative studies by Willoughby (1987) in central California demonstrated the negative impact of livestock grazing on two rare, endemic plant species. Fiedler and Leidy (1987), in a study of Ring Mountain Preserve, Marin County, CA, reported seven rare species in a serpentine bunchgrass community with a history of cattle grazing. Their study did not compare grazed with non-grazed sites. Heady (1956) demonstrated the positive influence of moderate grazing on *Stipa pulchra* Hitchc. but we know of no study that has quantified the positive influence of a livestock grazing regime on a rare, endemic California plant. In fact, few population studies have been carried out on endemic plants (Major 1988). At Point Reyes National Seashore most rare, endemic plants occur in the pastoral zone and livestock grazing may have had either a negative or positive influence on national seashore rare plants (Clark and Fellers 1986, 1987; Fellers and Norris 1990). In response to questions raised by the above discussion, we designed a field study to: establish a baseline for the *C. valida* population, monitor the influence of grazing, investigate other factors such as soils that may limit the population, and explore the potential to expand the colony.

STUDY AREA

The Abbotts Lagoon colony is located in western Marin County in Point Reyes National Seashore in northern California 38°6'N and 122°57'W. The terrestrial vegetation surrounding Abbotts Lagoon

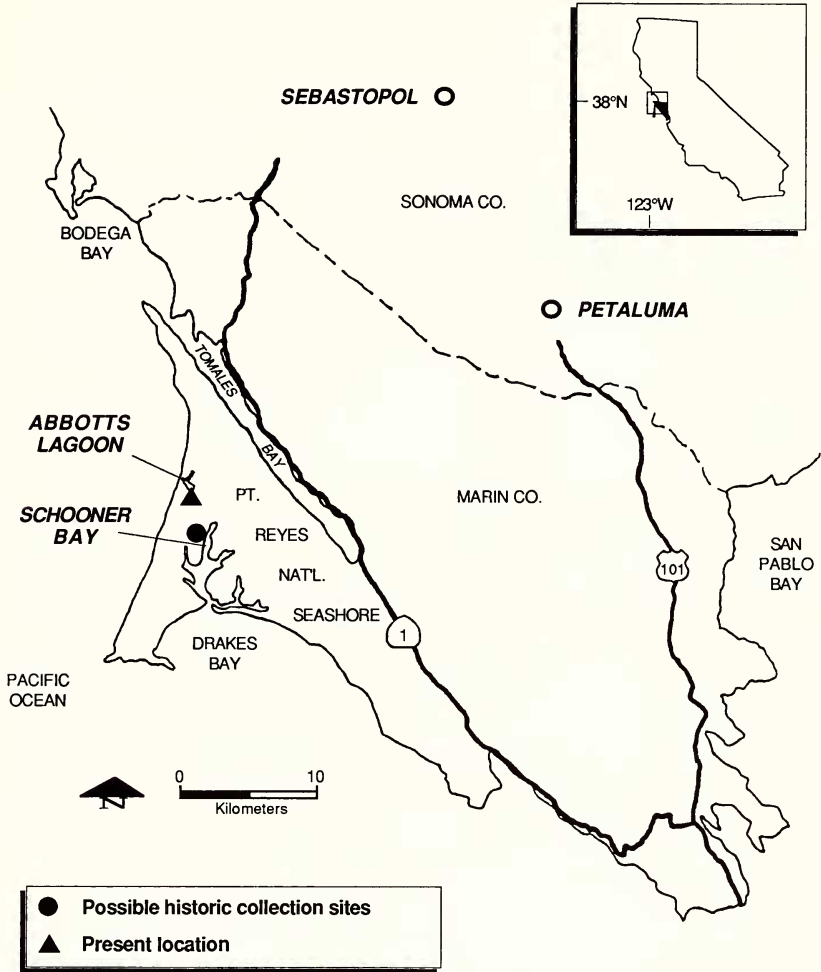


FIG. 1. Distribution of *Chorizanthe valida*.

is a mosaic of coastal grassland, coastal scrub, and sand dune (Barbour and Major 1988) and coastal swale.

The *C. valida* colony is located in coastal grassland, approximately 15 m above sea level. The total population exists within approximately 17,000 m² and is well defined within the larger coastal grassland community. The predominate grasses are *Vulpia bromoides* [= *Festuca dertonensis* (All.) Asch. & Graebn.], *Bromus mollis* L., and *Aira caryophyllea* L. and the predominate forbs are *Cardionema ramosissimum* (Weinm.) Nels. & Macbr. and *Rumex acetosella* L. Two shrub species, *Lupinus arboreus* Sims. and *Baccharis pilularis*

ssp. *consanguinea* (D.C.) C. B. Wolf., also occur in the colony but appear stunted at heights of <1 m.

According to the Soil Survey of Marin County, California (Kashiwagi 1985), the soil where the *C. valida* colony occurs is Sirdrak sand. This soil has low to moderate available water capacity and plants found there are drought tolerant.

Pastoralism was introduced to the Point Reyes Peninsula in the 1830's (Gogan et al. 1986). The site is a federally-leased cattle pasture that has a grazing history extending over a century (S. Phelan personal communication).

The area has a typical Mediterranean coastal climate. Records from the University of California Bodega Marine Laboratory, 23 km north, indicate mean temperatures are: January, 9.5°C; July, 13.6°C; annual, 11.5°C; and annual precipitation is 793 mm.

METHODS

Exclosures. During the June 1988 summer bloom two 4 m × 6 m cattle exclosures were constructed in different portions of the colony that contained large numbers of *C. valida*. Two circular plots with a radius of 0.81 m (area = 2.0 m²) were established in each exclosure. Two plots were also established in grazed areas within 22 m of each exclosure. *Chorizanthe valida* population counts were taken in 1988 (baseline) and over the next three consecutive summers (1989–1991) during the bloom. Also, in early June 1989 before a *C. valida* bloom, percentage cover baseline measurements were made along transects inside each non-grazed exclosure and the resulting plant species and percentages were recorded. Previous to this investigation there was year-around grazing and this practice continued during the course of our study.

Introduction plots. In September 1988 *C. valida* seeds were collected from the colony and 1000 seeds were selected for introduction in December 1988 into each of three 2 × 2 m plots located within the coastal grassland cattle pasture. The areas were devoid of *C. valida*, but within 100–200 m of the colony. The soil surface was exposed to a depth of 2–3 cm using a small hand shovel. The seeds were broadcast into the plots and pressed into the soil by foot pressure. *Chorizanthe valida* counts were made, both inside and outside of the plots, during the bloom over the next three years (1989–1991).

Soils. Soil samples were taken from the exclosures, from sample plots outside exclosures in the colony at points 10 m beyond the distinct periphery of the colony (*C. valida* < 1 m⁻²) in the four cardinal directions, and from the three introduction sites. Soil analyses were made for levels of nitrates, phosphorus, and potassium; pH; texture; and salinity.

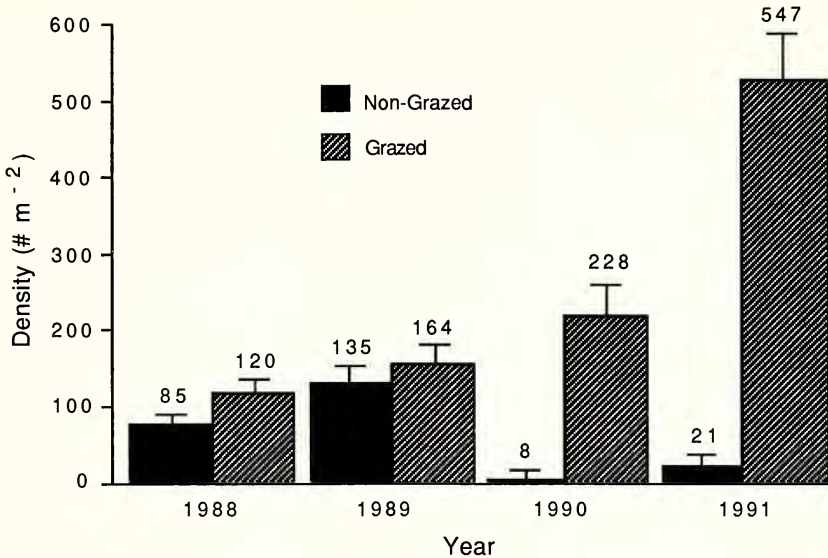


FIG. 2. Population densities of *C. valida*, non-grazed and grazed, over four years. Values above the bars indicate density. Error bars represent ± 1 SE of the mean.

Specimens were examined from CAS and from photocopies (GH, MO, and US). Nomenclature conforms to Munz (1968) except for *Vulpia bromoides* (Fellers et al. 1990).

RESULTS

Vegetation. After the 1988 baseline density counts, the colony showed an increase in both non-grazed and grazed spineflower populations (Fig. 2). A crash occurred, however, in the non-grazed populations from a density of 135 m⁻² in 1989 down to 8 m⁻² in 1990, but with a slight recovery in 1991 to 21 m⁻². The grazed population density continued to increase in 1991, up to 547 m⁻².

There are 236 non-native plant species recognized on the approximately 295 km⁻² at Point Reyes National Seashore (Fellers et al. 1990). Our percent cover measurements taken from transects inside exclosures for the 1989 growing season averaged 65% cover by non-native species, particularly non-native grasses (Table 1). Measurements were taken in early June before a significant *C. valida* bloom occurrence.

Differences in *C. valida* morphology inside and outside the exclosures were apparent in 1989 (Davis and Sherman 1990). Most plants in the non-grazed population were 3–4 times taller, had many more inflorescences, and greater crown diameters than the plants in the

TABLE 1. PLANT AND LITTER COVER INSIDE ENCLOSURES AFTER ONE YEAR OF NON-GRAZING.

Species	Native or non-native	Percentage cover
<i>Vulpia bromoides</i>	non-native	25.5
<i>Bromus mollis</i>	non-native	11.5
<i>Aira caryophyllea</i>	non-native	11.5
<i>Cardionema ramosissimum</i>	native	8.5
<i>Chorizanthe valida</i>	native	7.0
<i>Rumex acetosella</i>	non-native	6.0
<i>Hypochoeris radicata</i>	non-native	5.0
<i>Hordeum brachyantherum</i>	native	4.0
Litter	—	4.0
<i>Plantago lanceolata</i>	non-native	3.0
<i>Deschampsia caespitosa</i> ssp. <i>holciformis</i>	native	2.5
Bare ground	—	2.5
<i>Clarkia davyi</i>	native	2.0
<i>Lupinus arboreus</i>	native (?)	1.5
<i>Lupinus bicolor</i>	native	1.5
<i>Achillea borealis</i>	native	1.0
<i>Cynosurus echinatus</i>	non-native	1.0
<i>Lolium perenne</i>	non-native	1.0
<i>Danthonia californica</i>	native	0.5
<i>Layia platyglossa</i>	native	0.5
Cover summary		
65.0% from 8 non-native species		
28.5% from 10 native species		
6.5% litter/bare ground		

grazed population (Fig. 3). In 1991 one plant inside an enclosure measured 0.5 m in diameter and had 44 inflorescences.

Successful reproduction occurred within all three introduction plots and by 1991 two plots had reproduction outside of the original 2 × 2 m seeded area (Table 2).

Soils. Soil nutrients and textures in the colony, at the 10 m distant sample sites, and at the introduction sites were compared. There were no statistically significant differences. Within the colony, the means and ranges were as follows: nitrates 9 kg ha⁻¹ (8–10), phosphorus 19 kg ha⁻¹ (13–25), potassium 278 kg ha⁻¹ (200–390), soil pH 4.9 (4.6–5.4), and conductivity 347 μmhos (240–490). The soil texture was sand 91% (89–93), silt 5% (3–5), and clay 4% (3–5).

DISCUSSION

Halligan (1974) noted that cattle do not graze on *C. coriacea* associated with California sagebrush in annual grassland. Cattle do not appear to graze on *C. valida* or *C. cuspidata* var. *villosa* at Abbotts Lagoon. The reluctance of cattle to graze on *Chorizanthe* is no doubt



FIG. 3. *Chorizanthe valida* from (A) grazed and (B) non-grazed populations. L.H. Davis 9002 and 9003 (NCC), both collected 29 June 1989/mounted 1990.

due to the highly modified involucre abundant on each inflorescence. These spines, a major taxonomic feature for classification of the spineflower genus (Reveal and Hardham 1989; Howell 1985; Munz 1968), possibly represent an evolutionary adaptation for dispersal and/or grazing.

The remarkable differences in morphology between the grazed colony and the non-grazed colony demonstrate the phenotypic plasticity of *C. valida*. Major (1988), in response to the suggestion that restricted endemics lack plasticity, state, "Many apparently stenotopic endemics show extreme morphological variations when relieved of competition." In the case of *C. valida* it appears the reverse is true, extreme morphological variations occur when the species is subjected to apparent competition with other plants, when grazing pressures are removed.

During the course of this study the grazed population of *C. valida*

TABLE 2. RESULTS FROM THE INTRODUCTION OF *C. valida* SEEDS ON THREE PLOTS IN COASTAL GRASSLAND CATTLE PASTURE. Numbers in parentheses indicate additional plants found outside of the 2 × 2 m plots.

2 × 2 m plots	December 1988 seeds sown	Summer 1989 plant count	Summer 1990 plant count	Summer 1991 plant count
X	1000	38	3	16+ (3)
Y	1000	22	193	159+ (23)
Z	1000	98	2	9

increased remarkably, more than doubling from 1990 to 1991. Most populations fluctuate, either due to environment, or to intrinsic oscillatory properties (Ricklefs 1990). Changes in weather may have influenced *C. valida* population densities. The period from 1986–1991 was one of drought conditions. According to records from the University of California, Bodega Marine Laboratory, rainfall during our study was only 71% of normal.

Changes in grazing intensity would certainly contribute to density fluctuations. The National Seashore keeps grazing intensity records for each ranch unit. The ranch with the *C. valida* colony showed range management improvements from 1987 to 1990, however, the records are not sufficiently detailed to allow analysis of the specific *C. valida* site. We did not observe any changes in grazing intensity in our site visits over the four years of the study.

It may be that animals other than cattle have historically influenced this species. Edwards (1992) discusses the vast array of late Pleistocene (12,000 years ago) grazing-browsing-trampling mammalian megafauna of the Bay Area of central California. Today this megafauna is locally extinct, with the exception of deer and elk. Elk were extirpated and reintroduced. Large herds of Tule elk (*Cervus elaphus nannodes*) on Point Reyes in the last century are referred to by McCullough (1971). Evermann (1915) comments on elk inhabiting openlands up to five to six miles wide along the coast in Marin County. Presently an introduced elk herd exists 7 km north of the colony on Tomales Point within the National Seashore. The food habits of cattle overlap those of elk almost completely (McCullough 1971) and grazing by elk may have been an important factor in the earlier perpetuation of *C. valida*, however, the proportions of native and non-native plant species would have been different from those we observed in this study.

Other endemic animal associations are more evident. Stebbins (1974) stated that transport by animals is probably the most effective method for passive transport of the spiny hooked *Chorizanthe* seeds. Badger (*Taxidea taxus*), pocket gopher (*Thomomys bottae*), and blacktail jackrabbit (*Lepus californicus*) activity was observed in and near the colony. These mammals demonstrate some proclivity for coastal grassland habitat and emigration from the colony with attached seeds into nearby habitats would be expected. Also, during the summer bloom *C. valida* flowers attracted many hymenopteran species. We observed the solitary ground nesting wasp (*Bembix americana comata*), the yellow-faced bumble bee (*Bombus vosnesenkii*), and the non-native Italian honey bee (*Apis mellifera*) visiting *C. valida* flowers. Any or all of these insects may provide the means for outcrossing within the colony.

Recommendations for management. The apparent last remaining colony of *C. valida* is managed in a cooperative rare plant monitoring

program between Point Reyes National Seashore and The California Native Plant Society (Fellers and Norris 1990). Consideration should be given to expansion of the colony into the nearby coastal grassland mosaic on appropriate soils. An introduction program should consider the colony seed source as limited. The success of the three initial introduction plots demonstrates the potential for expansion of the colony. A small scale introduction program of one site per year may be appropriate.

Ornduff's (1974) discussion of successional disclimax plant communities refers to the Central Valley grasslands as being no longer dominated by native perennials but not replaced by an unnatural community of introduced annuals. The coastal grassland community at Abbotts Lagoon is also a disclimax (Elliott and Wehausen 1974). If livestock grazing were removed from these grasslands it is uncertain what successional changes would take place. Our study suggests that non-native plants would replace a rare, endemic plant that is apparently a poor competitor. A program that reassociates *C. valida* and native elk could be beneficial. Whichever programs are implemented, the perpetuation of *C. valida* will be a matter of constant human endeavor.

ACKNOWLEDGMENTS

At Point Reyes National Seashore we thank Superintendent John L. Sansing, Gary M. Fellers, Bill Shook, Seth Phelan, and Bruce Fields. We also thank Donald E. Isaac, Steve Barnhart, Peter G. Connors and John Maron. Partial funding was provided by a grant from the California Department of Fish and Game's Endangered Plant Project of the Nongame-Heritage Program.

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(Received 2 Oct 1991; revision accepted 3 Mar 1992.)